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14. ABSTRACT

During the summer of 2007, seven HBCU undergraduates from Jackson State University participated in our prostate cancer research and training program at Stevens Institute of Technology. In this HBCU Undergraduate Collaborative Summer Training program, we address detection and diagnosis of prostate cancer in two technology and application aspects, (a) remote detection and diagnosis through Internet and wireless networks and (b) computer-aided detection and diagnosis. With remote detection and diagnosis, we will provide prostate cancer screenings to men in rural regions and developing countries. With computer-aided detection and diagnosis, we will develop techniques to reduce the costs of telepathology for prostate cancer detection and diagnosis, both in termsoftransmissioncostsandonlinereadingcosts

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1. Introduction

1.1 PC-REU Research Objectives

Prostate cancer research experiences for undergraduates (PC-REU) are conducted under a HBCU Undergraduate Collaborative Summer Training program. The HBCU institute is Jackson State University and the research and training host institute is Stevens Institute of Technology. This is the third summer (2007) we run this program, which is based on the program designs and experiences we obtained from previous summers (2005 and 2006).

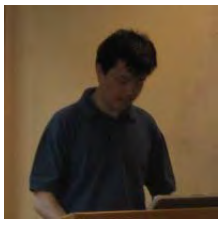
Prostate cancer is the most commonly diagnosed cancer in men and is the second leading cause of cancer deaths in men. Early detection offers the best chance at long-term survival. However, in rural areas or developing countries where pathologists or physicians who specialize in diagnosing prostate cancer are scarce, men have difficulties in accessing prostate cancer screenings and, therefore, incur a greater risk. Broadband access (high-speed Internet) is becoming available in more and more locations in the U.S. and it is thus desirable to take advantage of the broadband technology to improve health care for all Americans, including prostate cancer screenings for all American men. With the explosive development of information technologies (Internet, multimedia delivery, data mining), telecommunications infrastructures (wireline, wireless, satellite networks), and information processing techniques (imaging processing, automated detection and decision making), significant advances in telehealth technologies and applications, including telepathology and imaging techniques for early prostate cancer detection, are on the horizon.

In our research and training program PC-REU, we address detection and diagnosis of prostate cancer in two technology and application aspects, (a) remote detection and diagnosis through Internet and wireless networks and (b) computer-aided detection and diagnosis. With remote detection and diagnosis, we will provide prostate cancer screenings to men in rural regions and developing countries. With computer-aided detection and diagnosis, we will develop techniques to reduce the costs of telepathology for prostate cancer detection and diagnosis, both in terms of transmission costs and online reading costs. Thus with remote and computer-aided prostate cancer detection and diagnosis, it will have the advantage of higher penetration of men for cancer screening.

1.2 PC-REU Team 2007 and Projects

The following table summarizes the team of this year's training team and related projects.

PC-REU Team 2007 and Projects

<table>
<tr><td colspan="3"> 
PI/program director: Dr. Yu-Dong Yao (Stevens Institute of Technology)</td></tr>
<tr><td colspan="3"> 
HBCU faculty academic advisor: Dr. Robin Liu (Jackson State University)</td></tr>
<tr><td>Student</td><td>Mentor</td><td>Project/Topic</td></tr>
<tr><td> 
Vineeth Paul Tuluri</td><td rowspan="3"> 
Dr. Hong Man</td><td>Medical imaging analysis for cancer detection</td></tr>
<tr><td> 
Ricky Ykeam McGruder</td><td>Teleconsultation platform for remote detection and diagnosis of prostate cancer</td></tr>
<tr><td> 
Jamar Johnson</td><td>Teleconsultation platform for remote detection and diagnosis of prostate cancer</td></tr>
</table>

 **Micah Shears**	 Dr. Yang Meng	Detection and tracking algorithms
 **Shaughn Harris**		
 **Zamon Granger**	 Dr. Yu-Dong Yao	Bluetooth technology and applications in remote detection and monitoring
 **Frederick Windham**		Portable medical device for sensor/detection and notification Comblocks modules for test bed development for detection and diagnosis of prostate cancer via wireless communication networks

2. Report Body

2.1 The Training Program

2.1.1 Training Program Overview

In the summer of 2007, we ran our third-year research training program (PC-REU) under this award/funding support. Seven undergraduate students were recruited from HBCU/Jackson State University to participate in the training program. There are three mentors (Profs. H. Man, Y. Meng, and Y. D. Yao) from Stevens Institute of Technology directly advised the research. Prof. R. Liu served as HBCU faculty academic advisor. Additionally, Prof. W. Qian of Moffitt Cancer Center supported the research training program. Several graduate students also interacted with and advised the undergraduate trainees. The undergraduates participated in five projects (see subsection 2.2.2). PC-REU students also worked and interacted with other summer research students (in various programs such as Scholar-REU and Technogenesis-REU).

PC-REU students together with faculty mentors, support staff and other summer research students at Stevens.

2.1.2 Training Elements

This 10-week research training program is organized and scheduled into 10 units. There are learning elements (image processing algorithm, Java programming and socket programming) and laboratory assignments (electronic components selection and testing) for each unit. There are presentations and seminars by mentors and PC-REU students. Another important element is the weekly all-hands meetings.

2.1.3 Weekly Meetings

There are weekly all-hands meetings for trainees to report work progress and plans for the following week. The following shows several photos taken at the weekly meetings. Mentors, graduate students and undergraduate trainees have extensive interactions through the weekly meetings. Students also gain experiences in presentations and professional communication. Students set up personal research web page and post their weekly reports and research documents.

Weekly report/presentation at a weekly meeting (Vineeth Tuluri).

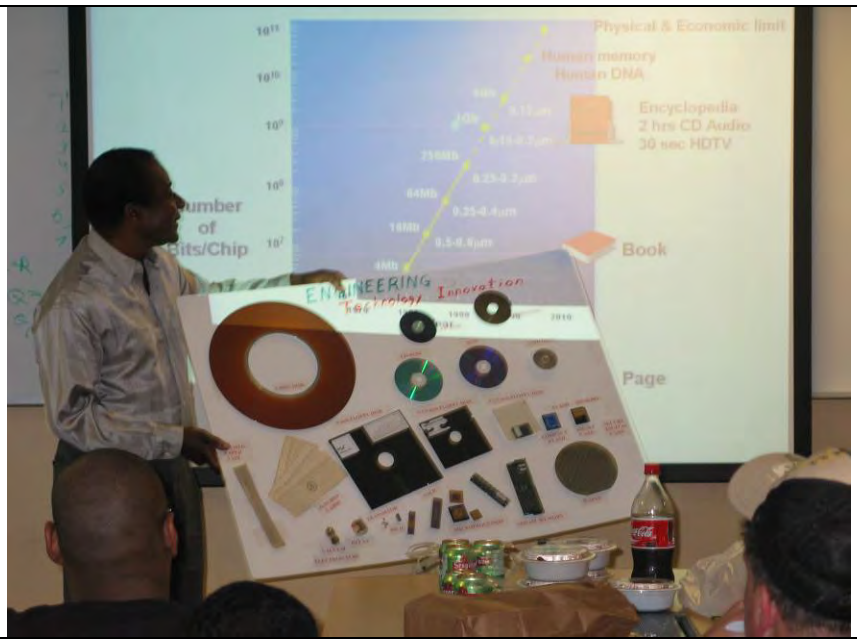
Weekly report/presentation at a weekly meeting (Jamar Johnson).

2.1.4 Seminars

Besides weekly meetings and presentations, research mentors gave seminars addressing specific research topics. PC-REU students also gave seminars reporting research results in focused research subjects.

Prof. B. McNair gives talk on wireless communications and networking.

Prof. H. Man gives a talk on medical imaging.



Prof. V. Lawrence gives a talk on the advances and applications of computer technologies.

Student Micah Shears gave a seminar on Prostate Cancer Diagnosis and Prevention.

Student Zamon Granger Prostate Cancer Statistics.

Student Vineeth Paul Tuluri gave a seminar on Prostate Cancer Treatment.

2.1.4 Mentor Involvement

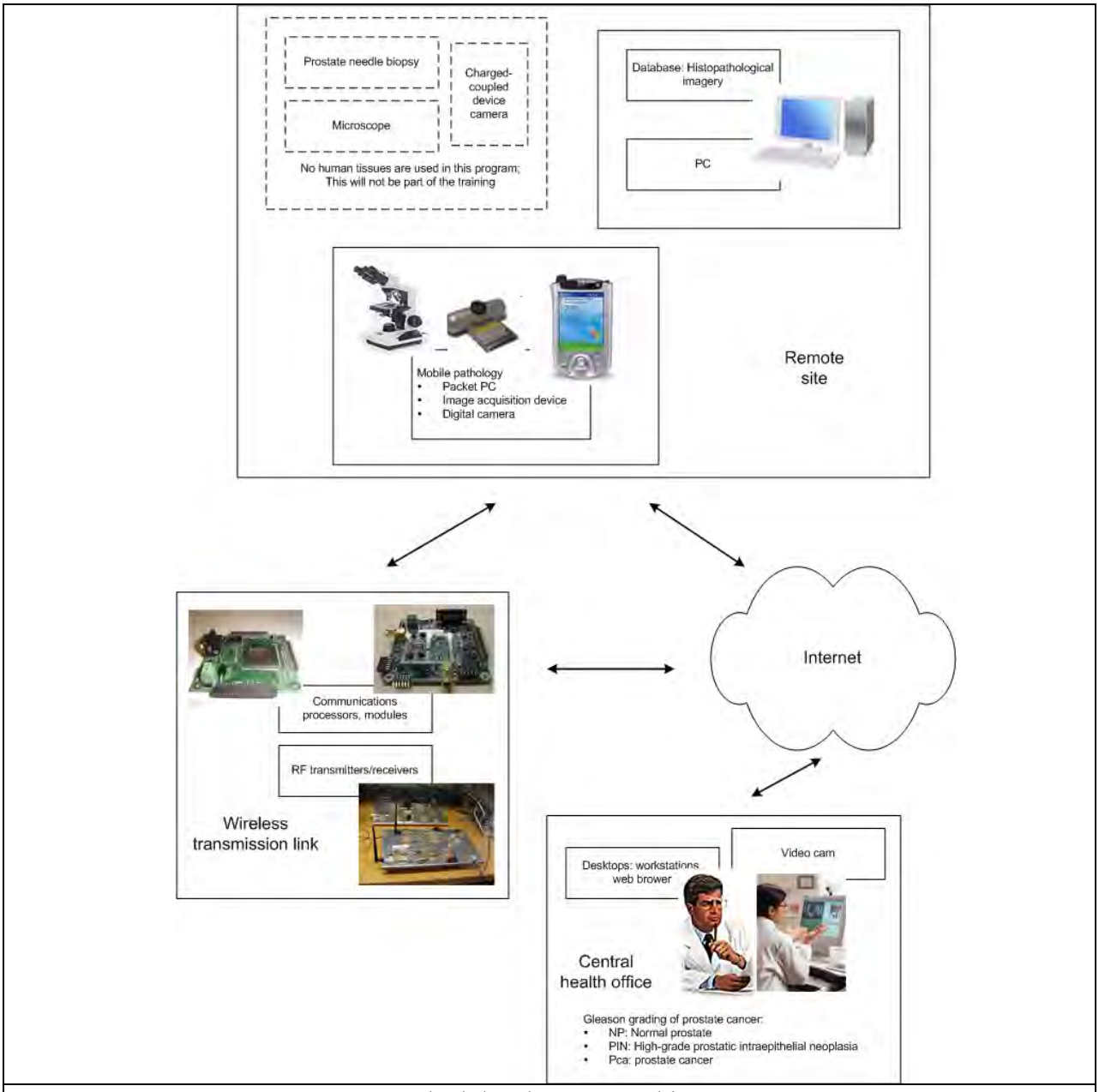
Faculty members (Dr. Yu-Dong Yao, Dr. Hong Man, and Dr. Yan Meng) interacted with students frequently. A number of graduate students worked with the undergraduates in a team and contributed significantly to the training program. Faculty mentors and undergraduate trainees attend weekly all-hands meetings. Such a group setting serves an important mentoring process. Additionally, faculty mentors visit the trainees in the research laboratory at least once a week, thus ensuring individual mentorship (mentor-trainee) once a week. Some faculty mentors have daily interactions with trainees.

Students work in a laboratory.

2.2 Study and Research Areas

2.2.1 Test Bed and Development Architecure

For this training program, a test bed development architecture contains three main elements, (1) a remote site, (2) transmission links, and (3) a central health office. Details of the test bed architecture for prostate cancer detection and diagnosis through Internet and wireless networks are illustrated below.



Test bed development architecture.

2.2.2 Projects

The following lists projects conducted in the summer program,

(1) Investigation of medical imaging and its applications in cancer detection and diagnosis: Studied medical imaging using CT (CAT), MRI, PET, and MSI technologies. Studied image analysis techniques including texture analysis, line detection, morphology, edge detection, segmentation, region-of-interest processing, and feature measurement.

(2) Development of a teleconference platform for remote detection and diagnosis of prostate cancer: Development of software platform using C++, Java using Java Native Interface. The platform supports communications via streaming video, voice, file transfer, text chat, and a white board. It supports communications among multiple users/terminals/locations.

(3) Application of C++ tool kit for image processing for prostate cancer detection and diagnosis: Student team first learned C++ then familiarizing with the Intel OpenCV under GNU Linux. Used the CImg library which is an open source C++ tool kit for image processing and it provides simple classes to load, save, process and display images in C++. The team restructured a program to load a JPEG image that when clicked on will display the intensity profiles of RGB of the corresponding image line. After which the team wrote a program to display intensity profiles of RGB on JNP files and looked at some more functions on OpenCV Image Processing. The system is then studied for image processing for prostate cancer detection and diagnosis

(4) Comblocks modules for test bed development for detection and diagnosis of prostate cancer via wireless communication networks: The basic task of the com blocks was to establish connection across transmitter and receiver without any disruptions. The Com block setup involved two platforms. On one platform it was the setup for the transmitter and the receiver setup was on the other platform. The platform setups consisted of comblocks connected to other comblocks. There were five comblocks for the transmitter and four comblocks for the receiver. Student team studies, integrates, and tests the modules and the integrated system.

(5) Bluetooth module development for portable medical devices (Mobile Medic) for monitoring, detection, and notification: The Mobile Medic is a wireless health sensor platform designed to monitor patient vitals remotely via Bluetooth and record data for storage, and alerting capabilities through a cell phone or PDA. An Nokia 6620 was selected in this project because it supported JSR-82 protocol where as many other phones did not. From the phone, the data can be transferred through the internet to a base station, and then transposed to a computer and recorded into a database, which is connected to a doctor's office.

2.2.3 Research Awards

Several research awards were presented at the end of the ten week summer program.

Each student in the program also created research poster at the end of the research.

3. Key Research Accomplishments

- A telehealth and telediagnosis network architecture was defined and updated, with applications to remote detection and diagnosis of prostate cancer
- A multimedia platform with audio, video streaming, text, and white board as applied to teleconsultation for remote detection and telediagnosis
- A comblock based wireless test bed was developed and updated for remote detection and diagnosis of prostate cancer through a wireless network
- A Bluetooth based sensor/notification platform, containing a detector (sensor), a transceiver (Bluetooth module), and a data storage device (cell phone).

4. Reportable Outcomes

Outcomes of this student training include,

- Developed a multimedia platform software package with audio, video streaming, text and white board applications, which is intended for communications between remote sites and a central office in a prostate cancer care network

- Developed a comblock based wireless test bed, which is a key component of a wireless test bed for the remote detection and diagnosis of prostate cancer

- Students' interests in graduate studies: Based on an end-of-training survey, students have increased interests in pursuing graduate studies after graduation

- Students' interests in pursuing careers in prostate cancer research: Based on an end-of-training survey, students have increased interests in pursuing careers in prostate cancer research and engineering research for medical systems and applications in general

5. Conclusions

This is the third year of the training program for HBCU students. This training program has given HBCU undergraduate students good opportunities to understand the importance of remote detection and diagnosis of prostate cancer. It shows engineering and science students (electrical and computer engineering and computer science) the role of engineering and technology in health care and medical services, especially in prostate cancer care. The training program also enables the undergraduate students interact with faculty and graduate students in learning and research and interact with other undergraduates at Stevens.

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